EXTERNALIZATION OF SURFACE ANALYSIS OVER CONTINENTAL AREAS FOR INCLUSION IN SURFEX

Final report based on the work done in METEO-FRANCE during the time

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by

Lora Taseva

National Institute of Meteorology and Hydrology
Bulgarian Academy of Sciences

66, Tzarigradsko chaussee, 1784 Sofia, Bulgaria
Email: Lora.Taseva@meteo.bg

Françoise Taillefer
METEO-FRANCE/CNRM/GMAP
42, av. G.CORIOLIS, 3 1057 TOULOUSE CEDEX, FRANCE
Email: Françoise.Taillefer@meteo.fr

François Bouyssel
METEO-FRANCE/CNRM/GMAP
42, av. G.CORIOLIS, 3 1057 TOULOUSE CEDEX, FRANCE
Email: François.Bouyssel@meteo.fr

METEO-FRANCE/CNRM/GMAP, TOULOUSE

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Lora Taseva (1), Françoise Taillefer (2), François Bouyssel 2)

(1) National Institute of Meteorology and Hydrology, Bulgarian Academy of Sciences
(2) METEO-FRANCE/CNRM/GMAP

INTRODUCTION

At present the surface fields are initialized within the CANARI/ARPEGE/ALADIN environment on the base of the analysis of 2m temperature and humidity (T_{2m}, H_{2m}) fields
The idea of initializing the off -line SURFEX model with atmospheric forcing with use of information from near surface observations led to the necessity of externalization of the surface analysis

The purpose of the work has been to develop an external package (outside the CANARI/ARPEGE/ALADIN environment) for surface analysis over the continental areas for inclusion in SURFEX.

The initialization of the surface fields for ARPEGE and ALADIN within the frame of CANARI is performed by the routines cacsts.F90, acsolw.F90,tsl.F90,cavegi.F90, the function fctveg.h and the relevant modules. The externalization of the surface analysis needed
modification of those routines, and development of some more routines for input-output .

The validation of the external package for surface analysis was performed over the ALADIN/FRANCE domain (300x300, mesh distance 9.5 km) for the case 2007071412

The comparison between the results , obtained by the reference analysis and the externalized software for initialization of the surface fields has been done in two steps:
- a reference run has been defined , based on the CANARI/ARPEGE/ALADIN produced by the executable
/mf/dp/marp/marp001/tampon/bin/ald/al32/al32t0_odb-op1v02.06.SX8RV20.x.exe.
hereafter called the operational MASTER run with NPROCG =1.
- the externalized surface analysis was produced by an executable EXTER_CACSTS on the bases of the routines ext_cacsts.F90, geometry_read.F90, clim_read.F90, analyz_read.F90, guess_read.F90, modified acsolw.F90, cacsts.F90, cavegi.F90, fctveg.F90, surf_write.F90 for 64-bit LINYX PC. The input files for the externalized software are the operational guess and analysis, as well as the climate files and POLYNOMES_ISBA

The report consists of Introduction, 4 sections and 3 Appendices

Section I Basic theory of initialization of the surface fields. Technical aspects of running the routines for initialization of the surface fields within the frame of the operational CANARI/ARPEGE/ALADIN analysis

Section II Description of the modifications, made in the routines for external initialization of the surface fields. Execution of the externalized package on 64-bit LINUX PC

Section III Comparison of the results obtained by running the externalized software with the results from the reference run

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Appendix 1
Table of the correspondence between the buffers in the operational CANARI/ARPEGE/ALADIN and the names of the arrays in the externalized routines

Appendix 2
Script for compilation and execution of the package for external initialization of the surface fields on 64 bit LYNUX PC

Appendix3
Distribution of the differences between the values of $(T_s, T_p, \omega_s, \ \omega_p)$ from the externalized initialization (ts2,tp2,ws2,wp2) and the operational run (ts,tp,ws,wp) over the (C+I) zone

Here : T_s is the surface temperature;

T_p - mean soil temperature;

ω_s - liquid soil moisture content;

ω_p - the deep soil moisture content

(C+I) zone – central plus coupling zone

Section I . Basic theory of initialization of the surface fields. Technical aspects of running the routines for initialization of the surface fields within the frame of the operational CANARI/ARPEGE/ALADIN analysis

I.1 Basic theory of initialization of the surface fields

In presenting the basic ideas of analysis of soil variables we will follow Giard and Bazile (2000). As it is described in their article, after the upper air variational analysis and the OI surface analysis of 2m fields T_{2m}, H_{2m} and 10m wind on the base of TEMP and SYNOP/SHIP observations, the final soil temperature and moisture are corrected on the bases of the optimal interpolation from 2-meters observations of temperature and relative humidity

The formulae for surface T_s and mean soil temperature T_p analysis are

$$\Delta T_s = \Delta T_{2m}; \ \Delta T_p = \Delta T_{2m} / 2\pi \qquad (1)$$

where Δ is the analysis increment

The analysis of soil moisture uses information from both T_{2m} and H_{2m} observations. The formulae for the liquid soil moisture content ω_s and the deep soil moisture content ω_p are

$$\Delta \omega_s = \alpha_s^T \ \Delta T_{2m} + \alpha_s^H \ \Delta H_{2m}$$

$$\Delta \omega_p = \alpha_p^T \Delta T_{2m} + \alpha_p^H \ \Delta H_{2m} \qquad (2)$$

The coefficients $\alpha_s^T, \alpha_s^H, \alpha_p^T, \alpha_p^H$ depend on soil texture, local solar time t^* (in hours), cloudiness (Cl) and the vegetation characteristics. Analytical formulae for determination of those coefficients is proposed in Giard and Bazile (1996)

$$\alpha_s^{T/H} = \frac{\delta\omega}{\delta\omega_r} \mathrm{B}\ (1\text{-veg})$$
$$\times\ [\mathrm{a}_0^{T/H}\ (t^*) + \mathrm{a}_1^{T/H}\ (t^*)\ \mathrm{veg}\ + \mathrm{a}_2^{T/H}\ (t^*)\, \mathrm{veg}^2\ ]$$

$$\alpha_p^{T/H} = \frac{\delta\omega}{\delta\omega_r}\ \mathrm{B\ x}\ \{\ (1\text{-veg})\ [\mathrm{b}_0^{T/H}\ (t^*) + \mathrm{b}_1^{T/H}\ (t^*)\ \mathrm{veg}\ + \mathrm{b}_2^{T/H}\ (t^*)\, \mathrm{veg}^2\ ]$$
$$+\ \ \mathrm{veg}\ \frac{LAI}{R_{sm}} [\mathrm{c}_0^{T/H}\ (t^*) + \mathrm{c}_1^{T/H}\ (t^*)\, \mathrm{veg}]\} \qquad (3)$$

Where $\delta\omega = \omega_{fc} - \omega_{wilt}$;

- ω_r - the reference for δω , corresponding to loam;
- B – empirical coefficients for additional dependency to meteorological conditions;
- LAI - leaf area index ,
- R_{sm} - minimum surface resistance
- veg – vegetation fraction

In Giard and Bazile (2000) the polynomial terms $\mathrm{a}_n^{T/H}\ (t^*)$, $\mathrm{b}_n^{T/H}\ (t^*)$, $\mathrm{c}_n^{T/H}\ (t^*)$ are derived from the available set of OI coefficients ($\alpha_{s/p}^{T/H}$) computed by Mahfouf (1991) and described in Giard and Bazile (1996), for loam and a few vegetation characteristics for each value of local time. With reference to Bouyssel et al. (2006), these coefficients have been modified :

- in October ‘ 99 by
  a/ Factor 3 reduction of OI coefficients on ω_p
  b/ Continuous formulations for OI coefficients
  c/ Cloudiness is taken into account in OI coefficients
- May ’03 by
  a/ Spatial smoothing of soil wetness index SWI
  b/ Improved 2m background error statistics (to represent smaller scales)
  c/ Factor 2 reduction of OI coefficients on ω_p
  d/ Zenith solar angle is taken into account
  e/ Remove temporal smoothing of ω_p analysis increments
  f/ No bias correction on T_{2m} analysis increments

I.2 Technical aspects of running the routines for initialization of the surface fields within the frame of the operational CANARI/ARPEGE/ALADIN analysis

The scripts for performing the reference run for 2007071412 with the operational MASTER (NPROCG =1) are on :

tori: ~/mrpa657/canari/reference/oper/ pre_bator
EXE_bator
pre_anal
anal_surf

cougar : /cnrm2_mrpa/mrpa/mrpa657/canari_2007

The input files are :

- /chaine/mxpt/mxpt001/france/oper/assim/$AA/$MM/JJ/rRR/guess
- /ch/mxpt/mxpt001/aladin/france/oper/const/clim/mens/clim_france_isba$MM
- /ch/mxpt/mxpt001/arpege/france/oper/const/autres/POLYNOMES_ISBA
- $FTDIR/ecma_bator_${dat}_${BATOR_NBPOOL}_cy32t0

Modifications of the operational namelists

- The routine castas.F90 performing the SST analysis is called before cacsts.F90 (the main routine for initialization of the surface fields) thus the analysis of over sea is done in the frame of the CANARI/ARPEGE/ALADIN. To be consistent with the idea of externalization of the initialization of the continental surface fields, the SST analysis has been excluded from the reference run by changing the namelist NACTEX (putting LAESST=.FALSE., RCLISST=0.).
- In the operational initialization of the surface fields, there is a spatial smoothing of SWI (soil wetness index) and then changing ω_p (casmswi.F90) after cacsts.F90. Due to the lack of time for modification of casmswi.F90 for externalization, to exclude that smoothing , the namelist NACVEG has been modified by putting L_SM_WP=.F.

The polynomials $a_n^{T/H}$ (t^*) , $b_n^{T/H}$ (t^*) , $c_n^{T/H}$ (t^*) are read from POLYNOMES_ISBA.

The result of the so defined reference run is on
$WORKDIR/anal_france_cy32t0_nosst_nosm_${dat}_${NPROCG}

Section II Description of the modifications, made in the routines for external initialization of the surface fields. Execution of the externalized package on 64-bit LINUX PC

The analysis of T_{2m} and H_{2m} , as well as the SST analysis, is a part of the CANARI OI analysis due to the fact that there are SST , TEMP and SYNOP/SHIP observations.
With the modifications, which will be described in this section, we have created a tool for external initialization of the surface fields only over the land . The source and the script for compilation and execution of the package for external initialization of the surface fields are on
cougar: /cnrm2_mrpa/mrpa/mrpa657/cacsts

II.1 Modification of the routines acsolw.F90 , cacsts.F90, cavegi.F90 and fctveg.F90

- The basic modifications in all routines of the externalized package have been connected with the replacement of reading-writing of the buffers in the operational CANARI analysis with reading-writing of the arrays for the variables according to the set-up routines. The table with the correspondence between the buffers and the name of the arrays is given in the Appendix1.
  During the modification of the routines it has been found that in CANARI in the routines cacsts and casmswi the variable "PROFRESERV.GLACE" has been defined as PS_SB(JROF,2,YSP_SB%YQ%MP0) ,
  while in the other routines in the physical part of the model this variable is defined as PS_SB(JROF,1, YSP_SB%YTL%MP0)
  Perhaps a change should be made in those 2 routines for consistence with the physical part of the code.
- To be completely outside the operational CANARI/ARPEGE/ALADIN environment, the use of modules have been replaced by explicit definition of all parameters inside the routines.
- The function fctveg.h for determination of the coefficients $\alpha_s^{T/H}$ and $\alpha_p^{T/H}$ as a function of time and the vegetation fraction , has been replaced by the subroutine fctveg.F90 to simplify the compilation of the package.
- The subroutine cavegi.F90 has been modified to read the coefficients $a_n^{T/H}$ (t^*) , $b_n^{T/H}$ (t^*) , $c_n^{T/H}$ (t^*) from POLYNOMS_ISBA and to define the time-dependant standard error statistics of the model.
- The modifications in cacsts.F90 additionally to the above mentioned common modifications, included calling the cavegi and fctveg subroutines.
- To avoid determination of T_s over sea, the parameter RCLISST was put to 0.
- The routine tsl.F90 has not been modified and its calling temporary was replaced by fixing the local solar time (IH=12), duration of the day (IDJ=12) and the local zenith angle (ZMU0=1)

II.2 The routine ext_cacsts.F90 has been created for :
- reading the input files : climate file (clim_read) , guess file (guess_read), T_{2m} and H_{2m} from CANARI analysis file (analyz_read) to define the increments ΔT_{2m} and ΔH_{2m}
- calling the cacsts
- writing the results (surf_write).

II.3 The script for compilation and execution of the package for external initialization of the surface fields (EXTER_CACSTS) on 64 bit LYNUX PC is given in Appendix2

II.4 When modifying the routines it turned out that in the ALADIN guess field the following arrays were missing: PATMNEB, PEVAP, PEVAPTR, PSSTC ('ATMONEBUL.BASSE.',

'SURFXFLU.MEVAP.E', 'SURFXEVAPOTRANSP', 'SURFSST.CLIM   '). They were initialized by 0. To include them it is necessary to change the relevant namelist parameters.

The arrays PWPINC1, PWPINC2, PWPINC3, PT2MBIAS, PH2MBIAS ('PROFINC.RESERV.1', 'PROFINC.RESERV.2', 'PROFINC.RESERV.3', 'SURFINC.TEMPERAT', 'SURFINC.HUMIDITE') also were missing and were initialized by 0. Since they are not used in the operational analysis, they are not included in the namelist parameters.

Section III. Comparison of the results from the reference run and those, obtained by running the externalized software for initialization of the surface fields.

As it has already been mentioned, the external initialization of the surface fields has been done only over the land.

The distribution of the differences of the fields ($T_s, T_p, \omega_s, \omega_p$) from the externalized initialization (ts2,tp2,ws2,wp2) and the operational run (ts,tp,ws,wp) over the whole domain has shown that there are some problems in the extension zone. They could be connected with the fact that the operational CANARI is performed only over (C+I) zone, while the externalized package runs over (C+I+E) zone. Due to the lack of time, we have not managed to make a relevant procedure for excluding the E zone, we have presented the distribution of the above mentioned differences over the (C+I) zone (Fig.1(ts2 – ts) , Fig.2(tp2 – tp), Fig.3(ws2 – ws), Fig.4(wp2 – wp) in Annex3). It is seen from the figures, that in general, the differences are small, except for deep soil water content (wp2 – wp) .

There are several possible sources for the difference between the surface fields, obtained by the operational and the externalized initialization:
- in the operational CANARI run there is a re-computation of the 2-meters guess fields, while in the externalized software they are taken directly from the operational (historical) files;
- the lack of a proper procedure for exclusion of the E zone when running the externalized package;
- some bug in the external software for initialization of the surface fields .

Section IV Conclusions and plans for the future work

The comparison between the results, obtained from the operational and externalized software for initialization of the surface fields shows that the differences between the obtained fields are not big. That means that the main goal of the work has been achieved and it is possible to run the developed software in externalized mode outside CANARI/ARPEGE/ALADIN.

The future work should be connected with :
- Use of ALADIN guess which contains the 3 missing fields. The experiments should be re-run and the differences between the surface fields, obtained by both software, should be to re-evaluated;
- Coding the dependence to the solar zenith angle
- Coding the smoothing of ω_p in the externalized package
- Avoiding corrections in the E zone

- Re-doing the comparison between the operational and externalized surface fields with a CANARI analysis without any re-computation of T_{2m} and H_{2m}. The coincidence of the results would indicate the correct externalization of the package for initialization of the surface fields
- Finding the proper way of ω_s and ω_p treatment over the sea.

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Appendix 1

Table of the correspondence between the buffers in the operational CANARI/ARPEGE/ALADIN and the names of the arrays in the externalized routines

```
**********
REAL(KIND=JPRB)                                    ,INTENT(INOUT)              ::
PSP_SB(KPROMA,YSP_SBD%NLEVS,YSP_SBD%NDIM)
REAL(KIND=JPRB)   ,INTENT(INOUT) :: PSP_SG(KPROMA,YSP_SGD%NDIM)
REAL(KIND=JPRB)   ,INTENT(INOUT) :: PSP_RR(KPROMA,YSP_RRD%NDIM)
REAL(KIND=JPRB)   ,INTENT(INOUT) :: PSP_CI(KPROMA,YSP_CID%NDIM)
REAL(KIND=JPRB)   ,INTENT(IN)    :: PSP_X2(KPROMA,YSP_X2D%NDIM)
***********
REAL(KIND=JPRB)   ,INTENT(INOUT) :: PSD_VF(KPROMA,YSD_VFD%NDIM)
REAL(KIND=JPRB)   ,INTENT(INOUT) :: PSD_VV(KPROMA,YSD_VVD%NDIM)
REAL(KIND=JPRB)   ,INTENT(IN)    :: PSD_VX(KPROMA,YSD_VXD%NDIM)
***********

! * Group SB=SOILB: soil prognostic quantities for the different reservoirs
(deep reservoir at MF)
!SB=SOILB soil prognostic quantities for the different reservoirs
!for second line - how to search them - see su_surf_flds

!PSP_SB(JROF,1,YSP_SB%YT%MP0)  :: YT !temperature              !!!
!PSP_SB(JROF,1,YSP_SB%YT%MP0)  :: YT !'PROFTEMPERATURE '       !!!PTP
!PSP_SB(JROF,1,YSP_SB%YQ%MP0)  :: YQ !liquid water content     !!!
!PSP_SB(JROF,1,YSP_SB%YQ%MP0)  :: YQ !'PROFRESERV.EAU  '       !!!PWP
!PSP_SB(JROF,2,YSP_SB%YQ%MP0)  :: YTL!ice water content         !!!
!PSP_SB(JROF,2,YSP_SB%YQ%MP0)  :: YTL!'PROFRESERV.GLACE'       !!!PTL

! * Group SG=SNOWG: surface snow prognostic quantities
!SG=SNOWG: surface snow prognostic quantities:
!for second line - how to search them - see su_surf_flds

!PSP_SG(JROF,YSP_SG%YF%MP0)    :: YF!content of surface snow     !!!
!PSP_SG(JROF,YSP_SG%YF%MP0)    :: YF!'SURFRESERV.NEIGE'          !!!PSNS

! * Group RR=RESERV: surface + superficiel reservoir prognostic quantities
!RR=RESVR: surface + superficial reservoir prognostic quantities
!for second line - how to search them - see su_surf_flds

!PSP_RR(JROF,YSP_RR%YT%MP0)    :: YT!skin temperature(Ts)          !!!
!PSP_RR(JROF,YSP_RR%YT%MP0)    :: YT!'SURFTEMPERATURE '            !!!PTS
!PSP_RR(JROF,YSP_RR%YW%MP0)!   :: YW!superf.reserv water content(Ws)!!!
!PSP_RR(JROF,YSP_RR%YW%MP0)!   :: YW!'SURFRESERV.EAU  '            !!!PWS



! * Group X2=XTRP2 : extra 2-d prognostic fields
! ( is used for precipitation fields in CANARI)
```

```
!PSP_X2(JROF,YSP_X2%YX2(1)%MP0) ! 'SURFPREC.EAU.CON'             !!!PRRCL
!PSP_X2(JROF,YSP_X2%YX2(2)%MP0) ! 'SURFPREC.EAU.GEC'             !!!PRRSL
!PSP_X2(JROF,YSP_X2%YX2(3)%MP0) ! 'SURFPREC.NEI.CON'             !!!PRRCN
!PSP_X2(JROF,YSP_X2%YX2(4)%MP0) ! 'SURFPREC.NEI.GEC'      !!!PRRSN
!PSP_X2(JROF,YSP_X2%YX2(5)%MP0) ! 'ATMONEBUL.BASSE '    !!!PATMNEB
!PSP_X2(JROF,YSP_X2%YX2(6)%MP0) ! 'SURFXFLU.MEVAP.E'    !!!PEVAP
!PSP_X2(JROF,YSP_X2%YX2(7)%MP0) ! 'SURFXEVAPOTRANSP'   !!!PEVAPTR

! * Group VF=VARSF: climatological/geographical diagnostic fields:
 TYPE TYPE_SFL_VARSF
! for second line - how to search them - see su_surf_flds

!PSD_VF(1,YSD_VF%YITM%MP)         :: YITM  !land-sea mask               !!!
!PSD_VF(1,YSD_VF%YITM%MP)         :: YITM  !'SURFIND.TERREMER'   !!!PITM
!PSD_VF(JROF,YSD_VF%YVEG%MP)   :: YVEG!vegetation cover             !!!
!PSD_VF(JROF,YSD_VF%YVEG%MP)   :: YVEG !'SURFPROP.VEGETAT'  !!!PVEG
!PSD_VF(JROF,YSD_VF%YALBF%MP)  :: YALBF !surface shortwave albedo !!!
!PSD_VF(JROF,YSD_VF%YALBF%MP)  :: YALBF !'SURFALBEDO     '    !!!PALBF
!PSD_VF(JROF,YSD_VF%YEMISF%MP) :: YEMISF!surface longwave emissivity !!!
!PSD_VF(JROF,YSD_VF%YEMISF%MP) :: YEMISF!'SURFEMISSIVITE  ' !!!PEMISF
!PSD_VF(JROF,YSD_VF%YZ0F%MP)     :: YZ0F  !gravity*surface roughness length!!!
!PSD_VF(JROF,YSD_VF%YZ0F%MP)      :: YZ0F !'SURFZ0.FOIS.G   '         !!!PZ0F

! * Group  VV=VCLIV: vegetation diagnostic fields: changed-see su_surf_flds
! for second line - how to search them - see su_surf_flds
! changed IF (LMPHYS.AND.(LSOLV.OR.LMSE)) THEN

!PSD_VV(JROF,YSD_VV%YIVEG%MP)) :: YIVEG!type of vegetation           !!!
!PSD_VV(JROF,YSD_VV%YIVEG%MP)) :: YIVEG!'SURFIND.VEG.DOMI'  !!!PIVEG
!PSD_VV(1,YSD_VV%YARG%MP)     :: YARG !silt percentage within soil   !!!
!PSD_VV(1,YSD_VV%YARG%MP)     :: YARG !'SURFPROP.ARGILE '      !!!PARG
!PSD_VV(1,YSD_VV%YD2%MP)        :: YD2  !soil depth                       !!!
!PSD_VV(1,YSD_VV%YD2%MP)        :: YD2  !'SURFEPAIS.SOL   '           !!!PD2
!PSD_VV(1,YSD_VV%YSAB%MP)     :: YSAB !percentage of sand within soil!!!
!PSD_VV(1,YSD_VV%YSAB%MP)     :: YSAB !'SURFPROP.SABLE  '        !!!PSAB
!PSD_VV(JROF,YSD_VV%YLAI%MP)  :: YLAI !leaf area index                !!!
!PSD_VV(JROF,YSD_VV%YLAI%MP)   :: YLAI !'SURFIND.FOLIAIRE'       !!!PLAI
!PSD_VV(JROF,YSD_VV%YRSMIN%MP) :: YRSMI!stomatal minimum resistance   !!!
!PSD_VV(JROF,YSD_VV%YRSMIN%MP) :: YRSMI!'SURFRESI.STO.MIN' !!!PRSMIN
!PSD_VV(JROF,YSD_VV%YZ0H%MP )  :: YZ0H !gravity*roughness length for heat!!
!PSD_VV(JROF,YSD_VV%YZ0H%MP )  :: YZ0H !'SURFGZ0.THERM   '       !!!PZ0H
```

```
! * Group VX=VCLIX: auxiliary climatological diagnostic fields:
! for second line - how to search them - see su_surf_flds
! changed-"IF (LCANARI.OR.LLFP_CLASSIC.OR.LLFP_SURFEX) THEN"!!
! - that is in  clim_france_isba$MM file :

!PSD_VX(JROF,YSD_VX%YTSC%MP)   :: YTSC !clim surface temperature       !!!
!PSD_VX(JROF,YSD_VX%YTSC%MP)   :: YTSC !'SURFTEMPERATURE '      !!!PTSC
!PSD_VX(JROF,YSD_VX%YTPC%MP)   :: YTPC !clim deep soil temperature     !!!
!PSD_VX(JROF,YSD_VX%YTPC%MP)   :: YTPC !'PROFTEMPERATURE '      !!!PTPC
!PSD_VX(JROF,YSD_VX%YPWS%MP)   :: YPWS !clim surface max. prop.moist. !!!
!PSD_VX(JROF,YSD_VX%YPWS%MP)   :: YPWS !'SURFPROP.RMAX.EAU'  !!!PWSC
!PSD_VX(JROF,YSD_VX%YPWP%MP)   :: YPWP !clim deep soil max. prop.moist.!!!
!PSD_VX(JROF,YSD_VX%YPWP%MP)   :: YPWP !'PROFPROP.RMAX.EAU'  !!!PWPC
!PSD_VX(JROF,YSD_VX%YSNO%MP)   :: YSNO !clim snow cover            !!!
!PSD_VX(JROF,YSD_VX%YSNO%MP)   :: YSNO !'SURFRESERV.NEIGE' !!!PSNC

! *  CANARI
!PSP_CI(JROF,YSP_CI%YCI(4)%MP0)  ! 'CLSTEMPERATURE  '            !!!PTCLS
!PSP_CI(JROF,YSP_CI%YCI(5)%MP0)  ! 'CLSHUMI.RELATIVE'            !!!PHCLS
!PSP_CI(JROF,YSP_CI%YCI(6)%MP0)  ! 'CLSVENT.ZONAL   '            !!!PUCLS
!PSP_CI(JROF,YSP_CI%YCI(7)%MP0)  ! 'CLSVENT.MERIDIEN'            !!!PVCLS
!PSP_CI(JROF,YSP_CI%YCI(8)%MP0)  ! 'SURFSST.CLIM    '            !!!PSSTC
!PSP_CI(JROF,YSP_CI%YCI(9)%MP0)  ! 'PROFINC.RESERV.1'            !!!PWPINC1
!PSP_CI(JROF,YSP_CI%YCI(10)%MP0) ! 'PROFINC.RESERV.2'            !!!PWPINC2
!PSP_CI(JROF,YSP_CI%YCI(11)%MP0) ! 'PROFINC.RESERV.3'            !!!PWPINC3
!PSP_CI(JROF,YSP_CI%YCI(12)%MP0) ! 'SURFINC.TEMPERAT'            !!!PT2MBIAS
!PSP_CI(JROF,YSP_CI%YCI(13)%MP0) ! 'SURFINC.HUMIDITE'            !!!PH2MBIAS
```

Appendix 2

Script for compilation and execution of the package for external initialization of the surface fields on 64 bit LYNUX PC

```
cd $TMPDIR/exe
set -x

fic1=clim_france_isba07
# the old operational analysis file
#fic2=anal_france_cy32t0_2007071412_4
#oper analysis 1 proc,without sst&smoothing of swi (L_SM_WP=.F.)
#fic2=anal_france_cy32t0_nosst_nosm_2007071412_1
#oper analysis 1 proc,without sst,but smoothing of swi (L_SM_WP=.T.)
fic2=anal_france_cy32t0_nosst_sm_2007071412_1
#
# the guess file
fic3=guess_france_2007071412
#
fic4=POLYNOMES_ISBA

#export paths = $HOME/cacsts/externalized/source
#echo " paths =" $paths

cat $HOME/cacsts/externalized/source/geometry_read.F90 > EXTER_CACSTS.F90
cat $HOME/cacsts/externalized/source/clim_read.F90 >> EXTER_CACSTS.F90
cat $HOME/cacsts/externalized/source/analyz_read.F90 >> EXTER_CACSTS.F90
cat $HOME/cacsts/externalized/source/guess_read.F90 >> EXTER_CACSTS.F90
cat $HOME/cacsts/externalized/source/ext_cacsts.F90 >> EXTER_CACSTS.F90
cat $HOME/cacsts/externalized/source/cacsts.F90 >> EXTER_CACSTS.F90
cat $HOME/cacsts/externalized/source/cavegi.F90 >> EXTER_CACSTS.F90
cat $HOME/cacsts/externalized/source/acsolw.F90 >> EXTER_CACSTS.F90
cat $HOME/cacsts/externalized/source/fctveg.F90 >> EXTER_CACSTS.F90
cat $HOME/cacsts/externalized/source/surf_write.F90 >> EXTER_CACSTS.F90

#tsl.F90

pgf90 -c -Kieee -byteswapio -tp x64 -Mfree -Mextend -DBLAS -DLINUX -DLITTLE_ENDIAN -
DLITTLE -DHIGHRES -g -O0 -Mscalarsse -
I/home/taseva/pack/31t1_main.01.PGI616.x/src/local/xrd/module EXTER_CACSTS.F90
pgf90 EXTER_CACSTS.o -o EXTER_CACSTS -L/home/taseva/pack/31t1_main.01.PGI616.x/lib -
lxrd.local -L/home/taseva/util/pgi -lmpidummyR64 -lgribexR64

cp $HOME/tmp/$fic4    fort.61
cp $HOME/tmp/$fic1    climfile
cp $HOME/tmp/$fic2    analysis
cp $HOME/tmp/$fic3    guessfil
cp $HOME/tmp/$fic2    analysis2

./EXTER_CACSTS

mv 'CLIM_MINMAX_OUT'   $HOME/cacsts/externalized/'CLIM_MINMAX_OUT'
```

```
mv 'ANALYZ_MINMAX_OUT'  $HOME/cacsts/externalized/'ANALYZ_MINMAX_OUT'
mv 'GUESS_MINMAX_OUT'   $HOME/cacsts/externalized/'GUESS_MINMAX_OUT'
mv 'ANALYZ2_MINMAX_OUT' $HOME/cacsts/externalized/'ANALYZ2_MINMAX_OUT'
```

Appendix 3

Distribution of the differences between the values of (T_s, T_p, ω_s, ω_p) from the externalized initialization (ts2,tp2,ws2,wp2) and the operational run (ts,tp,ws,wp) over the (C+I) zone

Here : T_s is the surface temperature;
T_p - mean soil temperature;
ω_s - liquid soil moisture content;
ω_p - the deep soil moisture content
(C+I) zone – central plus coupling zone

Fig.1 - (ts2 – ts)
Fig.2 - (tp2 – tp)
Fig.3 - (ws2 – ws)
Fig.4 - (wp2 – wp)

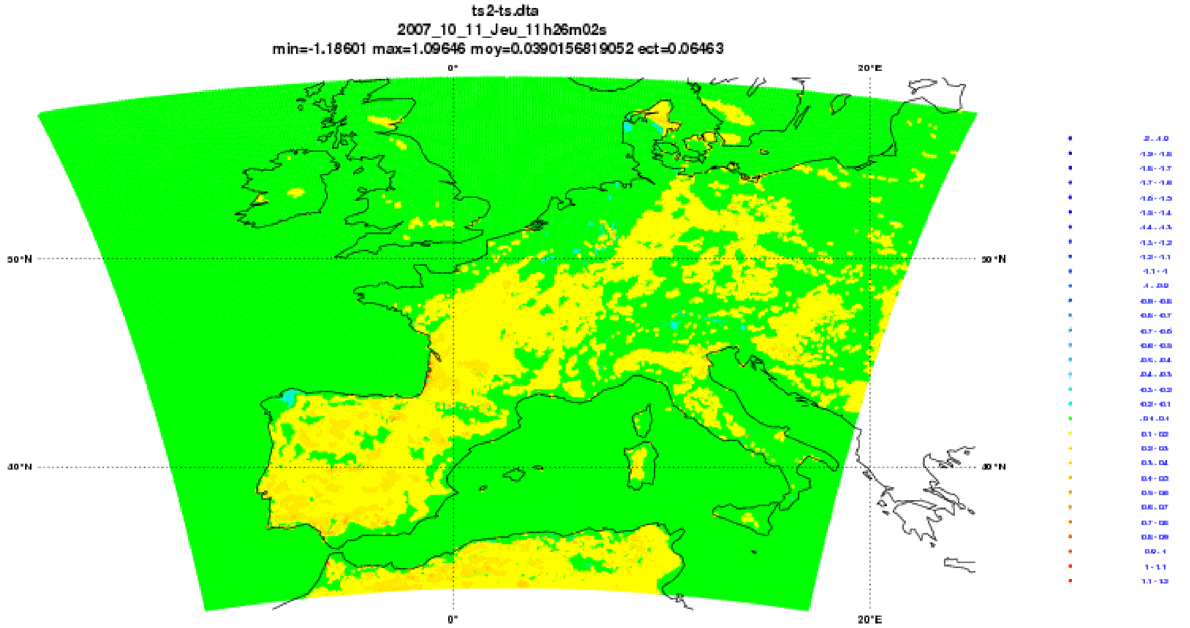


Fig.1 (ts2-ts)

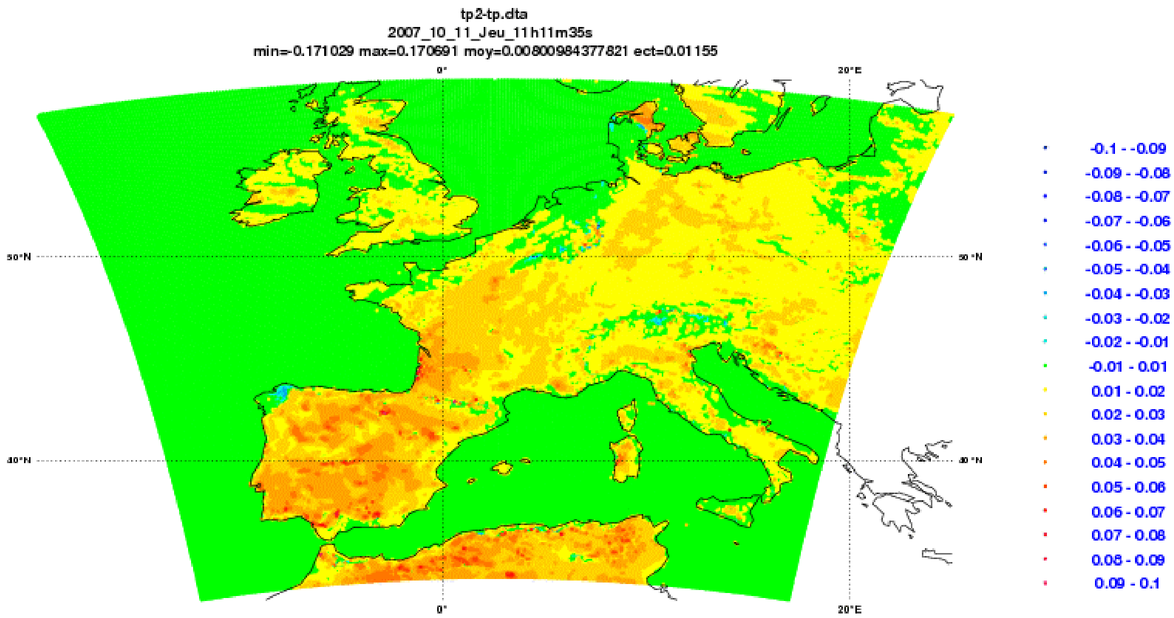


Fig.2 (tp2-tp)

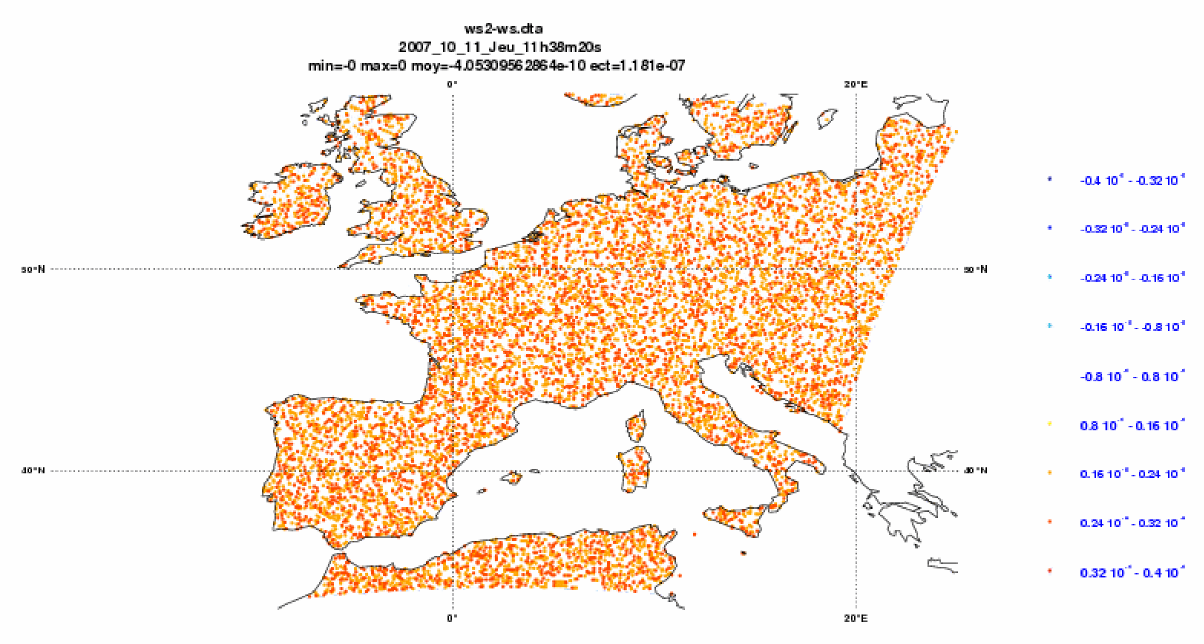
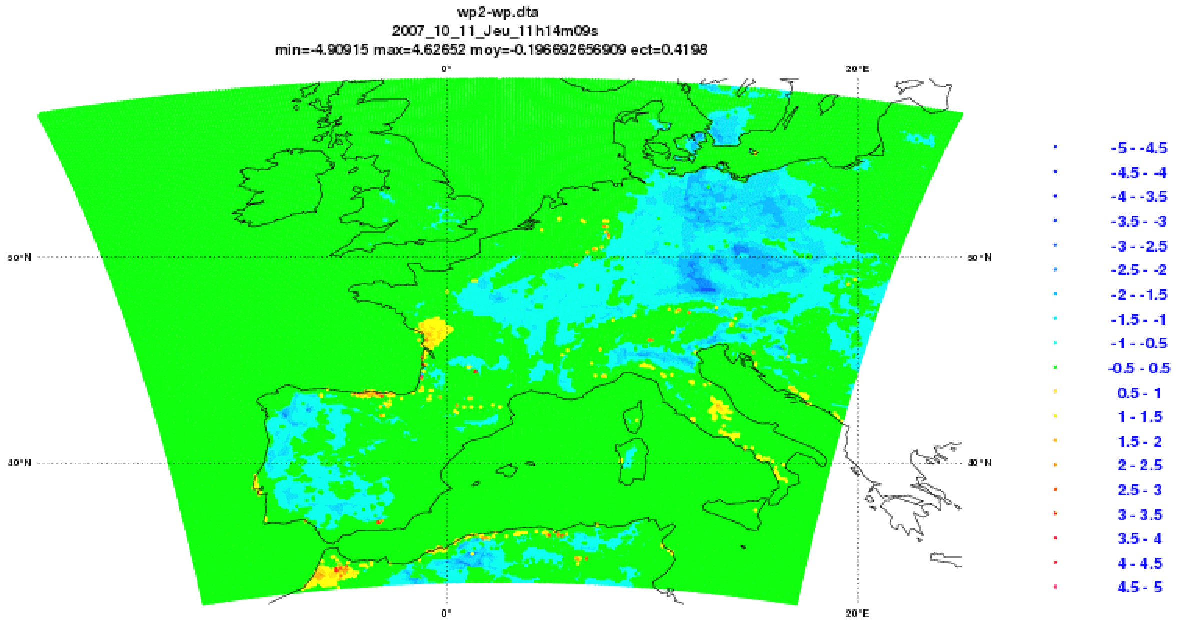

ws2-ws.dta
2007_10_11_Jeu_11h38m20s
min=-0 max=0 moy=-4.05309562864e-10 ect=1.181e-07
0°
20°E
50°N
40°N

Fig.3 (ws2-ws)


wp2-wp.dta
2007_10_11_Jeu_11h14m09s
min=-4.90915 max=4.62652 moy=-0.196692656909 ect=0.4198
0°
20°E
50°N
40°N
-5 - -4.5
-4.5 - -4
-4 - -3.5
-3.5 - -3
-3 - -2.5
-2.5 - -2
-2 - -1.5
-1.5 - -1
-1 - -0.5
-0.5 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 3.5
3.5 - 4
4 - 4.5
4.5 - 5